Level of Service Definitions

Signal Controlled Intersections

The level of service and capacity of a signalized intersection are the criteria by which the quality of traffic service is measured. The levels of service range between level of service A (relatively congestion-free) and level of service F (congested).

The capacity of a signalized intersection is based upon the concepts of saturation flow and saturation flow rate. This is the maximum rate of flow that can pass through a given lane group under prevailing traffic and roadway conditions. The volume-to-capacity ratio is the ratio of the traffic flow for a given lane group or approach to the capacity. A V/C ratio of 1.0 indicates that the flow rate equals the capacity. Values over 1.0 indicate a temporary excess of demand. This does not necessarily indicate an intersection failure.

The level of service of a signalized intersection is evaluated on the basis of average control delay per vehicle for various movements within the intersection. The control delay is a function of the arrivals, delay from queuing and over saturation.
The following general statements may be made regarding the level of service of a signalized intersection.

- ***Level of service A*** describes operations with a very low delay. This occurs when progression is extremely favorable and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short traffic signal cycles may contribute to low delay.
- ***Level of service B*** generally occurs with good progression and/or short traffic signal cycle lengths. More vehicles stop than for level of service A, causing higher average delays.
- ***Level of service C*** has higher delays than level of service B. These higher delays may result from fair progression and/or longer cycle lengths. Individual cycle failures, where motorists are required to wait through an entire signal cycle, may begin to appear in this level. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.
- ***Level of service D*** means the influence of congestion has become more noticeable. Longer delays may result from some combination of unfavorable progression, long

cycle lengths or high volume to capacity ratios. Many vehicles stop and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

- ***Level of service E*** is considered the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths and high volume to capacity ratios. Individual cycle failures are frequent occurrences.
- ***Level of Service F*** has delays that are considered unacceptable to most drivers. This condition often occurs with over saturations, i.e., when arrival flow rates exceed the capacity of the intersection. It may occur at volume to capacity ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

The following average stopped delays are utilized to determine intersection and approach roadway levels of service for signalized intersections:

LEVEL OF SERVICE	CONTROL DELAY PER VEHICLE (SEC)
A	$\leq$ 10.0
B	> 10.0 and $\leq$ 20.0
C	> 20.0 and $\leq$ 35.0
D	> 35.0 and $\leq$ 55.0
E	> 55.0 and $\leq$ 80.0
F	> 80.0

Two Way Stop Controlled Intersections

The level of service and capacity of a two-way stop controlled (TWSC) intersection are the criteria that are used to measure the quality of the traffic operations. The levels of service range between level of service A (relatively congestion-free) and level of service F (very congested).

The right of way at the TWSC intersection is controlled by stop signs on two opposing minor-street approaches (or on one leg of a “T”-type intersection). The capacity of a controlled approach is based on the distribution of gaps in the

major street traffic flow, driver judgment in selecting a gap through which to execute the desired maneuver and the follow up time required by each driver in a queue.

The level of service for the subject lane group movement of an approach of a TWSC intersection is evaluated based on the average total delay per vehicle. Control delay is a function of the capacity of the approach and the degree of saturation. It is defined as the

total elapsed time from the time a vehicle stops at the end of the queue to the time the vehicle departs from the stop line. This includes the time required for the vehicle to travel from the end of the queue position to the first-in-queue position, including deceleration of vehicles from free-flow speed to the speed of vehicles in the queue. The average approach delay for all vehicles on a particular approach is computed as the weighted average of the control delay estimates for each individual movement on the approach.

The following levels of average control delay are used to determine approach levels of service:

LEVEL OF SERVICE	CONTROL DELAY PER VEHICLE (SEC)
A	$\leq$ 10.0
B	> 10.0 and $\leq$ 15.0
C	> 15.0 and $\leq$ 25.0
D	> 25.0 and $\leq$ 35.0
E	> 35.0 and $\leq$ 50.0
F	> 50.0

While the level of service criteria are applied to each approach of a TWSC intersection, the average delay for an entire intersection can be calculated by taking a weighted average of the vehicles stopped on the minor approaches and the vehicles in the major street traffic flow, which suffer no delays. This total average control delay provides a means of comparison for two intersections.

All Way Stop Controlled Intersections

The level of service and capacity of an all way stop controlled (AWSC) intersection are the criteria by which the quality of traffic service is measured. The levels of service range between level of service A (relatively congestion-free) and level of service F (very congested).

The key variable in determining the capacity of an AWSC intersection is the distribution of traffic volumes among the approaches. Under ideal conditions traffic would be evenly distributed among the approaches. The flow rate for any given approach increases as the traffic decreases on the other approaches, allowing a smaller headway between vehicles departing from the stop line.

The capacity of each approach is computed under the assumption that the flows on the opposing and conflicting approaches are constant. The level of service of an AWSC intersection is evaluated based on the average total delay per vehicle. Total delay is defined as the total elapsed time from when a vehicle stops at the end of a queue until the

vehicle departs from the stop line. This includes the time required for the vehicle to travel from the end of the queue position to the first-in-queue position, including deceleration of vehicles from free-flow speed to the speed of vehicles in the queue. This delay is based on the flow rate for each approach. As indicated above, the flow rate and therefore the delay, is directly proportional to the distribution of vehicles among the approaches.

The following levels of average control delay are used to determine approach levels of service:

LEVEL OF SERVICE	CONTROL DELAY PER VEHICLE (SEC)
A	$\leq$ 10.0
B	> 10.0 and $\leq$ 15.0
C	> 15.0 and $\leq$ 25.0
D	> 25.0 and $\leq$ 35.0
E	> 35.0 and $\leq$ 50.0
F	> 50.0

The average control delay is the most effective measure for indicating the performance of an AWSC intersection because it can readily be measured by a transportation analyst and can be clearly communicated to a lay person. In addition, the use of delay will result in a consistent measure for both signalized and unsignalized intersections. While both types of intersections are evaluated in terms of average delay, the level of service criteria are different. This is due to drivers who expect different levels of performance from different types of intersection controls. Since signalized intersections are designed to carry higher traffic volumes compared with AWSC intersections, higher levels of control delay are more acceptable at signalized intersections for the same level of service.